Complete Summary

GUIDELINE TITLE

Epilepsy.

BIBLIOGRAPHIC SOURCE(S)

Karis JP, Seidenwurm DJ, Davis PC, Brunberg JA, De La Paz RL, Dormont PD, Hackney DB, Jordan JE, Mukherji SK, Turshi PA, Wippold FJ II, Zimmermann RD, McDermott MW, Sloan MA, Expert Panel on Neurologic Imaging. Epilepsy. [online publication]. Reston (VA): American College of Radiology (ACR); 2006. 8 p. [44 references]

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Tanenbaum L, Drayer BP, Anderson RE, Braffman B, Davis PC, Deck MD, Hasso AN, Johnson BA, Masaryk T, Pomeranz SJ, Seidenwurm D, Masdeu JC. Epilepsy. American College of Radiology. ACR Appropriateness Criteria. Radiology 2000 Jun;215(Suppl):459-70.

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

COMPLETE SUMMARY CONTENT

SCOPE

DISEASE/CONDITION(S)

Epilepsy

GUIDELINE CATEGORY

Diagnosis
Evaluation

CLINICAL SPECIALTY

Family Practice
Internal Medicine
Neurological Surgery
Neurology
Radiology

INTENDED USERS

Health Plans
Hospitals
Managed Care Organizations
Physicians
Utilization Management

GUIDELINE OBJECTIVE(S)

To evaluate the appropriateness of initial radiologic examinations for patients with epilepsy

TARGET POPULATION

Patients with epilepsy

INTERVENTIONS AND PRACTICES CONSIDERED

1. Magnetic resonance imaging (MRI), brain, without and with contrast
2. Magnetic resonance angiography (MRA), head
3. Functional MRI (fMRI), brain
4. Single-photon emission computed tomography (SPECT), brain
5. Positron emission tomography with fluorodeoxyglucose (FDG-PET), brain
6. Magnetoencephalography/Magnetic source imaging (MEG/MSI)
7. Computed tomography (CT), head, without and with contrast

MAJOR OUTCOMES CONSIDERED

Utility of radiologic examinations in differential diagnosis

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

The guideline developer performed literature searches of peer-reviewed medical journals and the major applicable articles were identified and collected.

NUMBER OF SOURCE DOCUMENTS

The total number of source documents identified as the result of the literature search is not known.

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Not Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Not stated

METHODS USED TO ANALYZE THE EVIDENCE

Systematic Review with Evidence Tables

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

One or two topic leaders within a panel assume the responsibility of developing an evidence table for each clinical condition, based on analysis of the current literature. These tables serve as a basis for developing a narrative specific to each clinical condition.

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Expert Consensus (Delphi)

DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS

Since data available from existing scientific studies are usually insufficient for meta-analysis, broad-based consensus techniques are needed to reach agreement in the formulation of the appropriateness criteria. The American College of Radiology (ACR) Appropriateness Criteria panels use a modified Delphi technique to arrive at consensus. Serial surveys are conducted by distributing questionnaires to consolidate expert opinions within each panel. These questionnaires are distributed to the participants along with the evidence table and narrative as developed by the topic leader(s). Questionnaires are completed by the participants in their own professional setting without influence of the other members. Voting is conducted using a scoring system from 1-9, indicating the least to the most appropriate imaging examination or therapeutic procedure. The survey results are collected, tabulated in anonymous fashion, and redistributed after each round. A maximum of three rounds is conducted and opinions are unified to the highest degree possible. Eighty percent agreement is considered a

consensus. This modified Delphi technique enables individual, unbiased expression, is economical, easy to understand, and relatively simple to conduct.

If consensus cannot be reached by the Delphi technique, the panel is convened and group consensus techniques are utilized. The strengths and weaknesses of each test or procedure are discussed and consensus reached whenever possible. If "No consensus" appears in the rating column, reasons for this decision are added to the comment sections.

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

Internal Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

ACR Appropriateness Criteria®

Clinical Condition: Epilepsy

Variant 1: Chronic epilepsy, poor therapeutic response. Surgery candidate.

Radiologic Procedure	Appropriateness Rating	Comments
MRI, brain, without contrast	8	
MRI, brain, without and with contrast	8	
FDG-PET, brain	7	May be helpful in pre-op planning.
CT, head, without and	6	

Radiologic Procedure	Appropriateness Rating	Comments
with contrast		
fMRI, brain	5	May be helpful in pre-op planning.
SPECT, brain	5	May be helpful in pre-op planning.
MEG/MSI	5	Data probably equivalent to BOLD and SPECT
CT, head, without contrast	5	
MRA, head	3	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: New onset of seizure. ETOH, and /or drug related.

Radiologic Procedure	Appropriateness Rating	Comments
MRI, brain, without and with contrast	8	In the acute or emergency setting, CT may be the imaging study of choice.
MRI, brain, without contrast	7	In the acute or emergency setting, CT may be the imaging study of choice.
CT, head, without and with contrast	6	In the acute or emergency setting, CT may be the imaging study of choice.
CT, head, without contrast	5	In the acute or emergency setting, CT may be the imaging study of choice.
MRA, head	2	
fMRI, brain	2	
SPECT, brain	2	
FDG-PET, brain	2	
MEG/MSI	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: New onset seizure. Aged 18–40 years.

Radiologic Procedure	Appropriateness Rating	Comments
MRI, brain, without contrast	8	In the acute or emergency setting, CT may be the imaging study of choice.
MRI, brain, without and with contrast	7	In the acute or emergency setting, CT may be the imaging study of choice.
CT, head, without and with contrast	6	In the acute or emergency setting, CT may be the imaging study of choice.
CT, head, without contrast	5	In the acute or emergency setting, CT may be the imaging study of choice.
SPECT, brain	4	
FDG-PET, brain	4	
MRA, head	2	
fMRI, brain	2	
MEG/MSI	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: New onset seizure. Older than age 40.

Radiologic Procedure	Appropriateness Rating	Comments
MRI, brain, without and with contrast	8	In the acute or emergency setting, CT may be the imaging study of choice.
MRI, brain, without contrast	7	In the acute or emergency setting, CT may be the imaging study of choice.
CT, head, without contrast	5	In the acute or emergency setting, CT may be the imaging study of choice.
SPECT, brain	4	

Radiologic Procedure	Appropriateness Rating	Comments
FDG-PET, brain	4	
CT, head, without and with contrast	3	In the acute or emergency setting, CT may be the imaging study of choice.
MRA, head	2	
fMRI, brain	2	
MEG/MSI	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 5: New onset seizure. Focal neurological deficit.

Radiologic Procedure	Appropriateness Rating	Comments
MRI, brain, without contrast	8	In the acute or emergency setting, CT may be the imaging study of choice
MRI, brain, without and with contrast	8	In the acute or emergency setting, CT may be the imaging study of choice
CT, head, without and with contrast	7	In the acute or emergency setting, CT may be the imaging study of choice
CT, head, without contrast	6	In the acute or emergency setting, CT may be the imaging study of choice
SPECT, brain	3	
FDG-PET, brain	3	
MRA, head	2	
fMRI, brain	2	
MEG/MSI	2	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

The classification of epileptic seizures by the International League Against Epilepsy was last revised in 1989 (see Appendix A in the original guideline document for an outline of the International Classification of Epileptic Seizures). The classification is important because etiologic diagnosis, appropriate treatment, and accurate prognostication all depend on the correct identification of seizures and epilepsy. There are two main seizure types: partial seizures and primary generalized seizures. Partial (formerly referred to as focal) seizures show either clinical or electroencephalography (EEG) evidence of onset from a localized area within the cerebral hemisphere. The nature of the signs and symptoms in most cases indicate the region of the brain involved by the epileptic process. Partial seizures are designated as simple or complex. Complex partial seizures are associated with loss of consciousness. In simple seizures, the epileptic process is usually confined to neocortical structures, and the limbic system and brainstem are spared. Most simple seizures are less disabling than those associated with loss of consciousness. Partial seizures can spread and develop into secondarily generalized seizures. Primary generalized seizures originate simultaneously from both cerebral hemispheres, and clinical manifestations involve both sides of the body. Primary generalized seizures first occur at an earlier age, and are more likely to be associated with a family history of seizure disorders, but are less likely to be associated with focal cerebral lesions. Some seizures remain unclassified because the underlying mechanism of their origin or propagation is unknown.

Certain types of seizure disorders are likely to be associated with structural brain lesions, including tumors, infection, infarction, traumatic brain injury, vascular malformations, developmental abnormalities, and seizure-associated brain pathology (see Appendix B in the guideline document), whereas others are not. Hence, knowledge of seizure types helps to determine whether neuroimaging is clinically indicated and what type of study is appropriate.

While the imaging evaluation of epilepsy was greatly advanced by the clinical introduction of computed tomography (CT) in the early 1970's, because of its superior soft tissue contrast, multiplanar imaging capability, and lack of beam hardening artifacts, virtually all the substrates of epilepsy are visualized with greater sensitivity and accuracy by magnetic resonance imaging (MRI). As a result, MRI has become the modality of choice for high-resolution structural imaging in epilepsy. Although routine evaluation techniques of all clinically available scanner field strengths may be sufficient for determination of mass lesions, optimized protocols for scans obtained on high-field (>1.5 T) scanners may be necessary for evaluating partial complex epilepsy, requiring scrutiny of the hippocampus and temporal lobe for atrophy and subtle signal alteration, as well as for detecting certain structural abnormalities such as cortical dysplasias, hamartomas, and other developmental abnormalities. Anatomic imaging identifies focal abnormalities in up to 51% of patients with partial epilepsy. With the widespread clinical availability of high-performance MRI systems, a comprehensive MRI examination, with functional techniques providing additional information, adding corroborative information, and improving overall accuracy, may in the future be of even greater value in epilepsy.

Although the data provided by MRI are essential in the presurgical evaluation of patients with medically refractory epilepsy, structurally detectable abnormalities are absent in many patients. In these patients, functional studies provide useful information on localization of the seizure focus. Functional imaging techniques, including positron emission tomography (PET), single-photon emission computed tomography (SPECT), magnetic source imaging (MSI), and functional MRI (fMRI), have contributed to the presurgical evaluation of patients with epilepsy.

Clinical PET with fluorodeoxyglucose (FDG) provides a measure of glucose uptake and thus metabolism. A seizure focus will typically manifest as a focus of hypometabolism on interictal (between episodes of seizure activity) examinations and will be seen as a focus of increased metabolism on ictal (during seizure) examinations. Interictal FDG-PET is sensitive (84%) and specific (86%) by electroencephalogram (EEG) criteria to temporal lobe epilepsy (TLE) and 33% sensitive and 95% specific to extratemporal epilepsy. By comparison, structural imaging using a variety of MR field strengths and techniques yielded a sensitivity and specificity of 55% and 78%. SPECT utilizing perfusion agents such as 99mTc-HMPAO or 99mTc-Neurolite, as well as bolus MRI perfusion provide an assessment of regional cerebral blood flow rather than brain metabolism. A seizure focus will typically manifest as a focus of hypoperfusion on interictal examinations and will be seen as a focus of increased activity on ictal examinations. The utility of isolated interictal cerebral perfusion assessment in patients without anatomic imaging abnormality is limited. The use of ictal/interictal subtraction imaging with coregistration on MRI and image-guided surgery datasets is proving to be more useful than interictal perfusion imaging alone. Injection of the blood flow agent within 90 seconds of seizure onset does, however, appear to be required to demonstrate the expected localized increase in cerebral perfusion. The use of perfusion techniques in epilepsy is therefore limited because of the technological challenge of injecting EEG-monitored patients within 90 seconds of seizure onset.

fMRI techniques include phosphorus and proton spectroscopy (MRS), perfusion, and blood oxygen level dependent (BOLD) activation. The widespread application of most of these techniques in clinical practice depends on the impending widespread availability of high-performance MR imagers capable of performing fast echo-planar pulse sequences (EPIs), as well as substantial data post-processing capabilities.

MRS is a set of noninvasive techniques for in vivo chemical analysis of the brain, some of which can be performed on standard-performance clinical MR units. Although MRS has been used extensively for the past 30 years in molecular physics and chemistry, its application to the study of epilepsy is relatively recent. Widely available proton and phosphorus single-voxel techniques have consistently demonstrated metabolite changes in the epileptogenic region of the brain. MRS or chemical shift imaging (CSI) allows simultaneous acquisition of spectra from all brain regions. The pictorial display of MRS information facilitates comparison of the epileptogenic zone with the remainder of the brain and provides localizing information. Chemical shift imaging is not yet widely available in clinical practice. Initial studies suggest that both proton and phosphorus MRS will be useful adjunctive presurgical tests for localizing seizure foci in patients with partial epilepsy, particularly in difficult cases, potentially reducing the need for intracranial-depth electrode EEG recordings and those with extratemporal seizure foci.

Only magnetoencephalography (MEG) and EEG are capable of measuring epileptic brain activity directly and with high temporal resolution. The temporal resolution of PET, SPECT, and fMRI is poor by comparison (sec-min). Recent improvements in MEG technology now allow whole brain coverage and overlay of source information on MR or CT images (with MSI). Available data indicate that interictal MEG can be an effective tool for localization of seizure foci in patients with medical refractory partial epilepsy. Significant shortcomings include limited availability, high cost, and assessment limited to relatively superficial and tangential sources. Nonetheless, MSI does provide unique, accurate, and useful information about epileptogenic regions in the brain, and where available, has a potential role in the diagnostic workup of most patients with epilepsy.

Abbreviations

- BOLD, blood oxygen level dependent
- CT, computed tomography
- ETOH, ethyl alcohol
- FDG-PET, fluorodeoxyglucose-positron emission tomography
- fMRI, functional magnetic resonance imaging
- MEG, magnetoencephalography
- MRA, magnetic resonance angiography
- MSI, magnetic source imaging
- PET, positron emission tomography
- SPECT, single-photon emission computed tomography

CLINICAL ALGORITHM(S)

Algorithms were not developed from criteria guidelines.

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The recommendations are based on analysis of the current literature and expert panel consensus.

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

Selection of appropriate radiologic imaging procedures for evaluation of patients with epilepsy

POTENTIAL HARMS

Not stated

QUALIFYING STATEMENTS

QUALIFYING STATEMENTS

An American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

IMPLEMENTATION TOOLS

Personal Digital Assistant (PDA) Downloads

For information about availability, see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Living with Illness

IOM DOMAIN

Effectiveness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

Karis JP, Seidenwurm DJ, Davis PC, Brunberg JA, De La Paz RL, Dormont PD, Hackney DB, Jordan JE, Mukherji SK, Turshi PA, Wippold FJ II, Zimmermann RD, McDermott MW, Sloan MA, Expert Panel on Neurologic Imaging. Epilepsy. [online publication]. Reston (VA): American College of Radiology (ACR); 2006. 8 p. [44 references]

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

1996 (revised 2006)

GUIDELINE DEVELOPER(S)

American College of Radiology - Medical Specialty Society

SOURCE(S) OF FUNDING

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

GUIDELINE COMMITTEE

Committee on Appropriateness Criteria, Expert Panel on Neurologic Imaging

COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE

Panel Members: John P. Karis, MD; David J. Seidenwurm, MD; Patricia C. Davis, MD; James A. Brunberg, MD; Robert L. DeLaPaz, MD; Pr. Didier Dormont; David B. Hackney, MD; John E. Jordan, MD; Suresh Kumar Mukherji, MD; Patrick A. Turski, MD; Franz J. Wippold II, MD; Robert D. Zimmerman, MD; Michael W. McDermott, MD; Michael A. Sloan, MD, MS

FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

Not stated

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Tanenbaum L, Drayer BP, Anderson RE, Braffman B, Davis PC, Deck MD, Hasso AN, Johnson BA, Masaryk T, Pomeranz SJ,

Seidenwurm D, Masdeu JC. Epilepsy. American College of Radiology. ACR Appropriateness Criteria. Radiology 2000 Jun;215(Suppl):459-70.

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

GUIDELINE AVAILABILITY

Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.

ACR Appropriateness Criteria® *Anytime*, *Anywhere*™ (PDA application). Available from the ACR Web site.

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

AVAILABILITY OF COMPANION DOCUMENTS

The following is available:

- ACR Appropriateness Criteria®. Background and development. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.

PATIENT RESOURCES

None available

NGC STATUS

This summary was completed by ECRI on July 31, 2001. The information was verified by the guideline developer as of August 24, 2001. This summary was updated by ECRI Institute on April 26, 2007.

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